A Mechanized SOIL-CORE SAMPLER for Gravimetric Moisture Determinations

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Growth Through Agricultural Progress

A MECHANIZED SOIL-CORE SAMPLER FOR GRAVIMETRIC MOISTURE DETERMINATIONS

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A number of mechanical devices for obtaining soil samples for various purposes have been developed over the years. The principal reasons for the development of these machines were to reduce the amount of labor necessary for sampling, to speed the operation so that more samples could be obtained in a given period, and to obtain samples for special purposes such as undisturbed cores for certain physical determinations. These machines have ranged from simple devices utilizing compressed air to very elaborate and complex motor-driven units. Examples of some of the units developed over the years are the ones designed by Kelley et al., Blaney and Taylor, Donnan et al., and others.[2] Each of these machines was designed to fill a specific need.

Gravimetric soil moisture determinations have been made at the Big Spring Field Station for over 35 years. For many years the samples for moisture determination were obtained by manually driving and pulling a soil tube. In order to speed the operation, a modification of the Bull[3] soil sampler (Chambers, 1952) was constructed in a local machine shop in 1953. This sampler was mounted behind a farm tractor with the tractor hydraulic system being used as a power source. This sampler worked very well for standard sampling operations. However, only one core could be secured at one location without moving the tractor. This was not a serious problem where considerable distances between sampling sites was involved but where large numbers of soil cores were needed for small areas, the continual moving of the tractor became laborious and time consuming.

This problem became especially acute in an experiment involving soil moisture extraction patterns under various cotton row systems. In order to adequately study moisture extraction patterns it was necessary that soil cores be obtained at close intervals across each plot. As many as nine samples at one location across a plot were required for certain row systems. This necessitated moving the tractor a distance of 20 inches across the plot for each core since the sampler was rigidly attached to the tractor. In addition to being laborious, damage to the experimental plants occurred by passage of the tractor wheels over them.

In order to circumvent this difficulty the sampler shown in figure 1 was designed and constructed in the station machine shop. Insofar as possible, standard materials that are easily obtainable were used in the construction. The Big Spring soil-core sampler is so designed that the tube-driving apparatus or power probe[4] (which is similar to the Bull sampler) can be moved laterally along a track behind the tractor so that a core sample can be obtained at any point along the track. This permits the tractor to travel in the same direction as the crop rows are oriented

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[2]Blaney, H. F., and Taylor, C. A. 1931. Soil Sampling with a Compressed Air Unit. Soil Sci. 31: 1-2.

Chambers, H. M. 1952. Soil Sampling by Push-button. U.S.D.A., S.C.S., Work and Management Improvement, page 34, July.

Donnan, W. W., Aronovici, V. S., and Fox, W. W. 1943. Imperial Valley Soil Sampling Apparatus. Soil Sci. Soc. Amer. Proc. 8: 367-371.

Jensen, M. E., Sletten, W. H., and Ochs, R. L. 1960. Mechanized Soil Sampler with Offset Drive. Amer. Soc. Agr. Engin. Trans. Vol. 3, No. 1.

Kelley, O. J., Hardman, J. A., and Jennings, D. S. 1947. A Soil-Sampling Machine for Obtaining Two-, Three-, and Four-inch Diameter Cores of Undisturbed Soil to a Depth of Six Feet. Soil Sci. Soc. Amer. Proc. 12: 85-87.

U. S. Soil Conservation Service. 1953. Soil Survey Field Letter. U. S. Dept. Agr., pp. 16-17, June.

[3]The Bull hydraulic sampler was designed by A. D. Bull, Soil Conservation Service, U. S. Department of Agriculture, and is covered by one or more of the following government patents: Nos. 2701121, 2881933, and 2868019.

[4]Construction details of the tube-driving apparatus may be obtained from A. D. Bull, Soil Conservation Service, Chickasha, Okla.

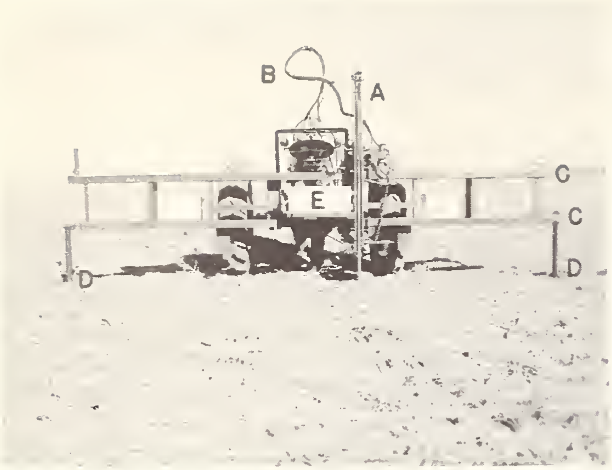


Figure 1.--Overall rear view of Big Spring core sampler: (A) Tube-driving apparatus or power probe; (B) hydraulic hose and electric cable; (C) upper and lower tracks; (D) counterpoise; (E) soil can box and rack.

without damage to the crop and allows a succession of core samples without moving the tractor.

Figure 1 gives an overall view of the Big Spring core sampler taken from the rear of the tractor. The tube-driving apparatus is slightly to the right of the center of the tractor in this view. The track is constructed of steel I-beam braced at frequent intervals to compensate for the weight of the tube-driving apparatus. Adjustable counterpoises are located at each end of the track to counteract the thrust when a core is being secured at the opposite end of the track. In actual use these counterpoises were seldom found to be necessary. The lower track is mounted at the same level as the tractor axle. The sampler is thus usable in crops as tall as the tractor axle. The track length is governed by such factors as need, soil rigidity, and effective tractor weight. The track length in this instance is 20 feet, thus cores can be obtained up to 10 feet to either side of the center of the tractor. This distance permits successful coring of an Amarillo fine sandy loam soil to a depth of 4 feet when the sampler is mounted on a four-plow farm tractor. The effective weight including the sampler was 8,000 pounds. Three boxes to hold moisture cans are carried on racks attached to the track. The hydraulic hose extending from the tractor to the tube-driving apparatus is attached to a hose tender to prevent fouling.

In figure 2 the method of mounting the tube-driving apparatus on the I-beam track can be observed. The power probe is attached to four heavy-duty casters which roll along the track. The two casters in the upper track carry the weight of the power probe. The two inverted casters in the lower track serve to stabilize the tube-driving apparatus and prevent it from turning sidewise in movement or when a sample is being secured.

Figure 3 gives a detailed rear view of the mounting mechanism on the upper track. The tube-driving apparatus is moved along the track by means of two electric starter motors attached to flexible cables fixed at

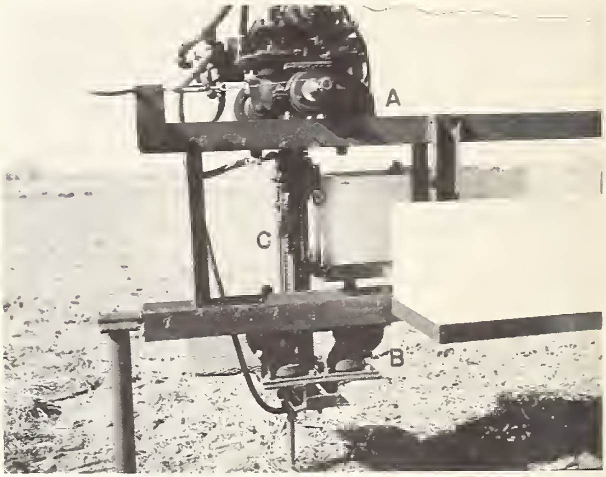


Figure 2.--Rear detail of Big Spring sampler showing method of mounting tube driving apparatus to track: (A) Casters in upper track; (B) inverted casters in lower track; (C) double acting hydraulic cylinder.

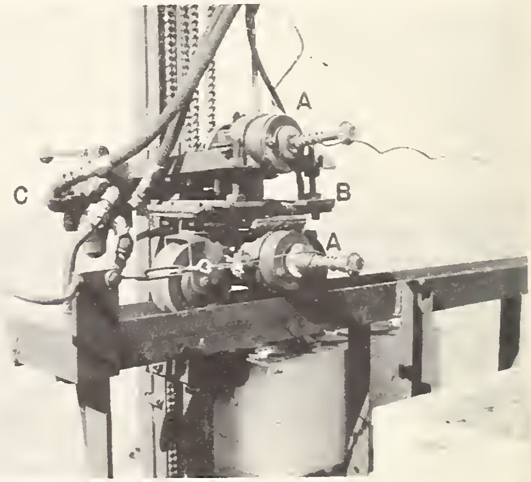


Figure 3.--Detailed view of mounting mechanism and method of locomotion: (A) Electric starter motors that pull power probe along track; (B) bolts used to level power probe and maintain tension between upper and lower rollers; (C) hydraulic control valve and hoses.

the ends of the track. A reversible motor would serve equally as well if available. Also shown in figure 3 is the method of leveling the power probe and maintaining tension between the upper and lower rollers. This is accomplished with four bolts attached to a plate on the upper rollers. The bolts are in turn fastened to two beams welded to the tube-driving apparatus. By tightening and loosening the lock nuts on these bolts as necessary, tension between the upper and lower rollers may be maintained. If there is appreciable slack between the rollers, the sampler does not work satisfactorily. To the left of the starter motors the hydraulic hoses attached to the hydraulic control valve which operates the tube-driving mechanism may be observed.

The controls for the sampler may be seen in figure 4. To the left of the tube-driving apparatus is a reversible electric switch that activates the electric starter motors to move the tube-driving apparatus along the track. To the right is the control valve that transmits hydraulic power to the double-acting cylinder to push the soil tube into and to pull it from the soil. Also shown are two rollers attached to the casters, which roll along the flat side of the I-beam track to give added stability. They have not been found to be absolutely necessary.

Figure 4.--Detailed view of controls: (A) Electric switch which activates starter motors; (B) hydraulic control valve; (C) power probe; (D) Viehmeyer tube in position in power probe; (E) stabilizing rollers.

Figure 5 shows a soil core being secured with the tube-driving apparatus at the extreme right of the track. Normally a two-man crew is used in coring soils for moisture determinations but this unit can be operated very effectively by one man. The operation of the hose tender can be observed in this figure. A standard Viehmeyer soil tube is being used to secure the soil core. Larger diameter cores useful for density, permeability, and root distribution studies may also be secured with this power probe.

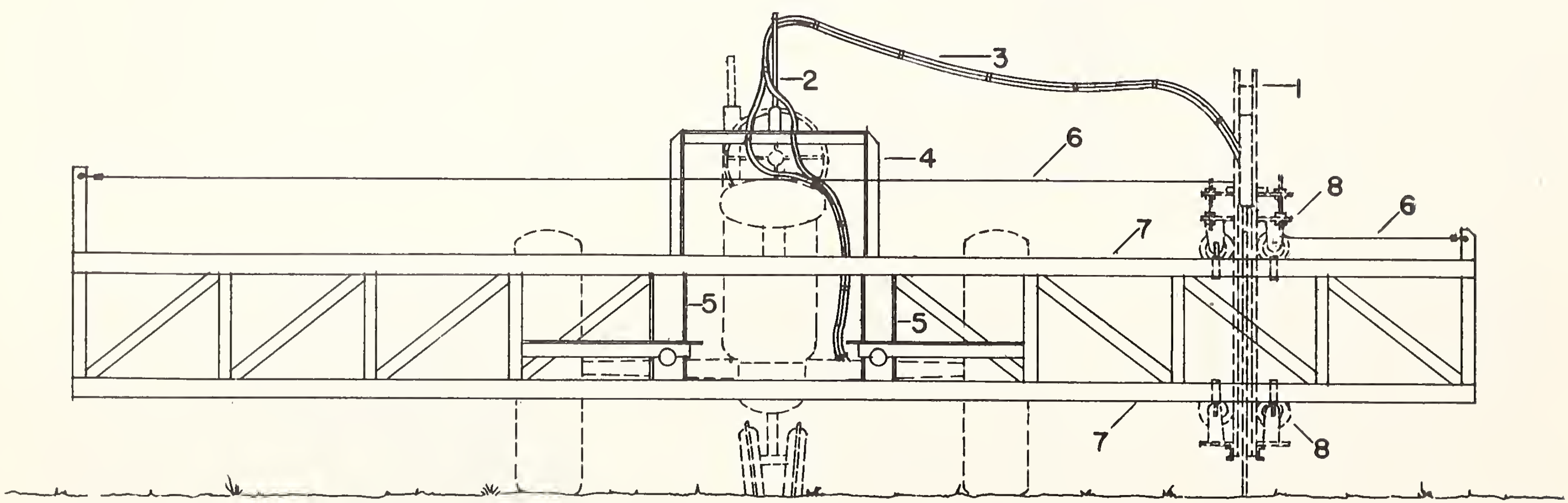
Figure 5.--Operators taking soil core with the tube-driving apparatus at the extreme right of track: (A) Power probe; (B) hose tender and hydraulic hose; (C) soil tube.

This sampler has been in use for 2 years at the Big Spring Field Station. It has worked extremely well under the soil and moisture conditions prevailing at Big Spring. The soils range in texture from fine sandy loam to clay loam and are often near the wilting percentage. Over 12 thousand 1-foot core samples have been obtained annually with the unit with only minor repairs being necessary.

The Big Spring core sampler is useful for obtaining soil cores for moisture determinations at close intervals across a plot. It can also be used to sample small plots without getting machinery on the plot itself by driving the tractor down an alleyway adjacent to the plot. Larger diameter cores obtained with the sampler are useful for density determinations, permeability tests, and root distribution studies.

Construction details of the Big Spring soil-core sampler are presented in figures 6, 7, and 8.

1. POWER PROBE
2. HOSE TENDER
3. HYDRAULIC HOSE & ELECTRIC CABLE
4. HOSE TENDER SUPPORT
5. I-BEAM SUPPORTS
6. FLEXIBLE CABLE TO PULL PROBE
7. I-BEAM TRACK
8. MOUNTING MECHANISM



REAR ELEVATION SCALE 1/2" = 0.8'

THE BIG SPRING SOIL CORE SAMPLER

Figure 6

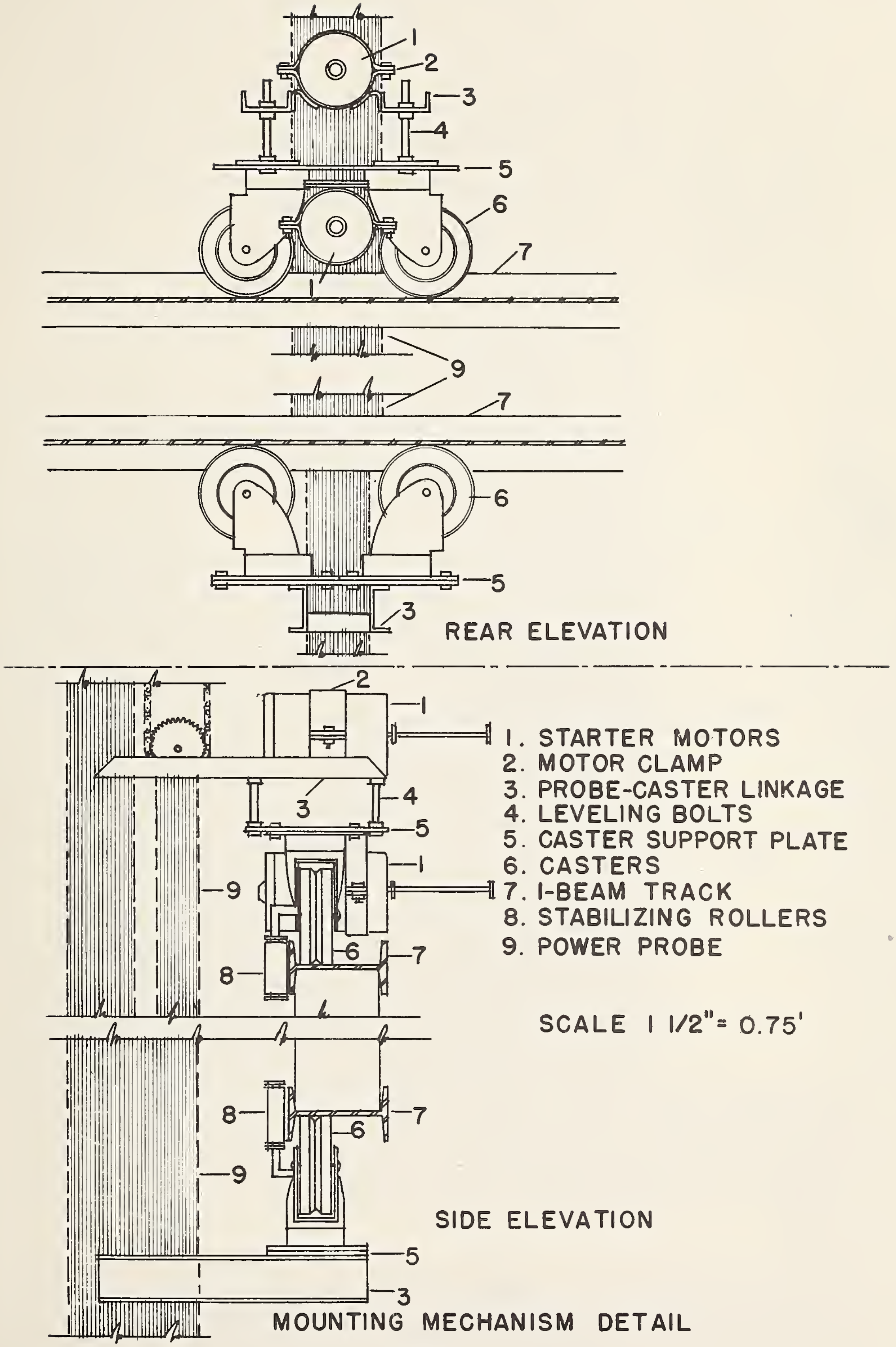
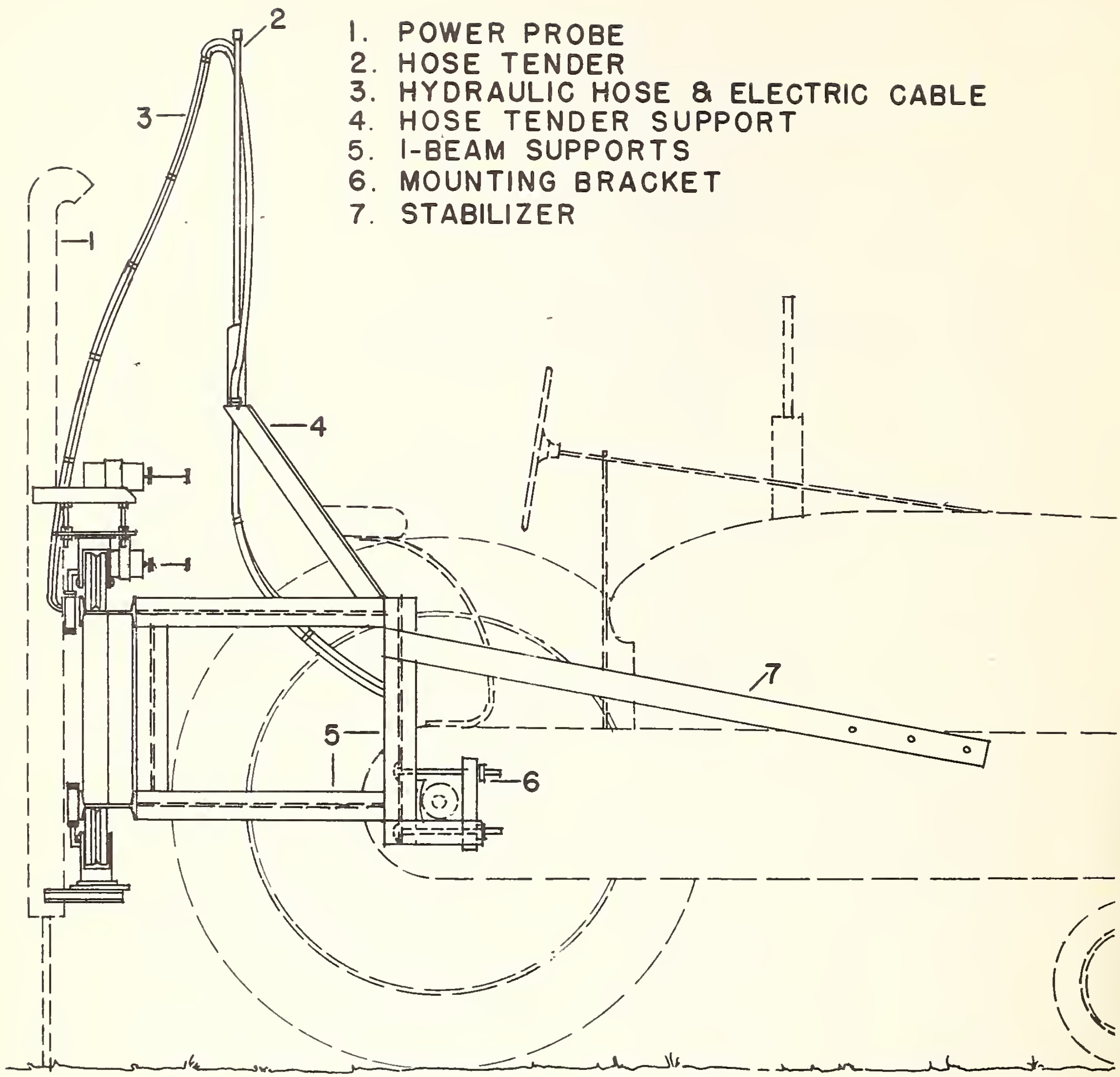

REAR ELEVATION
1. STARTER MOTORS
2. MOTOR CLAMP
3. PROBE-CASTER LINKAGE
4. LEVELING BOLTS
5. CASTER SUPPORT PLATE
6. CASTERS
7. I-BEAM TRACK
8. STABILIZING ROLLERS
9. POWER PROBE
SCALE 1 1/2" = 0.75'
SIDE ELEVATION
MOUNTING MECHANISM DETAIL

Figure 7



SIDE ELEVATION SCALE 3/4"=0.8'

Figure 8